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MECHANIZATION IN THE CHEDDAR CHEESE PROCESS

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THE size and design of equipment for making Cheddar cheese have been changed greatly during the last 25 years. The use of much larger vats, electric pumps and milk lines, wider curd knives, mechanical agitator-forkers, power curd mills, hydraulic presses and mechanical refrigeration has reduced the amount of hand labour required (1, 2). Also, the use of a controlled time-schedule method for making Cheddar cheese from milk pasteurized by the HTST method has increased plant capacity, improved cheese quality and reduced labour costs (3, 4, 5).

Until recently, few changes in the actual making procedure were either proposed or made with the aim of reducing the amount of hand labour or the manufacturing time. However, during the past few years, many attempts have been made to develop such changes. A modification of the early stirred-curd method seemed to be the most promising means of reducing time and/or labour without an accompanying loss in the flavour, texture or body of the resultant cheese (6). In general, cheese made with most of the various modifications has had a more open texture than that made with conventional methods, and consistently satisfactory results have not been obtained under controlled laboratory conditions.

Close-textured cheese was obtained by Stine, who pressed the curd in heated whey (7), but most of the bacteria used as starters do not develop acid normally at temperatures above 105°F. However, Walter *et al.* (8) used *Streptococcus durans*, which is heat- and salt-tolerant, in conjunction with the usual lactic starter and obtained normal acid development. Consequently, a short-time method was developed by them in 1953, whereby the curd was hooped in hot, salted whey. With this procedure the trapped air, which is responsible for most of the mechanical openings, is eliminated. This method required only from $2\frac{1}{2}$ to $3\frac{1}{2}$ h. The body, texture and flavour of the cheese were good, and the cheese was free from mechanical openings. However, there were several objections to this method (9, 10). It required special cheese-making equipment and a special hooping process, and the salted whey presented a disposal problem.

Czulak *et al.* (9) modified the U.S.D.A. method by using a more rapid starter, only a 5-min ripening period, a second cooking temperature of 110°–116°F and, significantly,

a short matting period instead of hooping the curd in salted whey. Cook (11) reported that 470,000 lb of good cheese were made under commercial conditions. Except for some mechanical openings, the cheese was generally uniform in quality, smooth and waxy, clean flavoured and had excellent cutting properties. Results obtained with this method in the United States and in Scotland have been reported (12–15).

During continued studies, Czulak & Hammond (16) failed in attempts to obtain close-textured cheese with modified granular-curd methods unless the curd was hooped in whey. Their observations led them to assume that a flattening and an elongation of the curd particles are necessary for the development of the fibrous structure of Cheddar cheese. This concept led to development by them of a curd-fusing machine that flattens and elongates the curd in whey at 108°F during a 30 min cheddaring period.

Czulak (16) reported the successful development of a new, mechanized method for making Cheddar cheese of good quality, including descriptions of the curd-fusing machine and the automatic milling, salting and hooping equipment. He stated that this equipment would "replace the work of up to 7 out of 10 men per each 10,000 gal of milk handled". Also, it would require less factory space and reduce manufacturing time.

Other equipment and procedures involved in the development of mechanized cheese-making methods include the Steinecker, Alchorn and other machines (1, 15, 17–19) and the Harper & Seiberling continuous method for making cheese curd (20).

A NEW LABOUR-SAVING METHOD

A major objective of cheese research in this laboratory for many years has been the development of practical means of reducing labour costs in the manufacture of Cheddar cheese. Therefore, it seemed desirable to investigate the possibility of modifying the previous procedures (8, 10) on the basis of the following assumptions: (i) a saving of labour is more important than a saving in manufacturing time; (ii) some mechanical openings in Cheddar cheese are not objectionable to cheese-makers or consumers; and (iii) a labour-saving method should differ as little as possible from conventional methods.

The results show that the tedious and costly hand labour required in the conventional matting and cheddaring steps can be eliminated by a rather simple change in present procedures. The new method (21) has been tested repeatedly on a pilot-plant scale. It is distinctly different from the "simplified short-time method" (10).

The new method follows the 7-h U.S.D.A. method (3) except during the period from draining the whey to milling the curd. Instead of draining off the whey, the mixture of curd and whey is pumped by a rotary-type, positive-displacement pump from the vat directly into a large, cloth-lined, perforated, stainless-steel "curd retention and matting device" which has been placed in a tank (described later). The mixture is discharged at the top of the device. The curd forms a layer under the whey, and most of the free air entrapped between curd particles is released and comes to the surface of the whey. The excess whey is drained off as the curd–whey mixture is being pumped, leaving enough in the tank to cover the curd. When pumping has been completed, the cheese-cloth is folded over the curd, a perforated top plate is put on the covered curd, weights (30 lb/sq. ft) are added and the whey is drained from the

tank. Whey drains from the curd and the curd is allowed to mat for 2 h without being turned. Then the large block of curd is removed and cut into about $\frac{3}{4}$-in. slabs suitable for milling.

Conventional procedures are followed in milling, salting, hooping, dressing and pressing the curd.

In addition to the obvious labour-saving feature, the cheese vat is available for re-use as soon as the pumping of curd and whey has been completed. Also, the new procedure can be carried out under controlled conditions, and it should yield a uniform product.

The "curd retention and matting device" was composed of 3 parts: a body, a bottom and a top plate. The body was $22 \times 45\frac{7}{8}$ in. inside and 23 in. high. It was perforated with $\frac{1}{4}$-in. circular holes located every $2\frac{1}{2}$ in. on centre throughout the lower half. The bottom was $21\frac{7}{8} \times 45\frac{3}{4}$ in. inside and 1 in. high. It was perforated throughout and was attached to the body with thumbscrews. The top plate was $21\frac{7}{8} \times 45\frac{3}{4}$ in. and was also perforated throughout. All parts were made of stainless steel. This device was large enough to hold the curd from 4,000 lb of milk. The tank was slightly larger than the curd-retention device, and was deep enough to ensure complete coverage of the curd with whey throughout the pumping period. Further research and the commercial use of the curd-retention and matting device may indicate a more desirable size and shape than described here. Also hydraulic pressure instead of weights would be used in commercial factories.

RESULTS

The results obtained with this method on an experimental, pilot-plant scale have been exceedingly promising. The cheese has had the same general characteristics and composition as cheese made with the conventional 7-h method. It has had a typical cheese flavour, a few mechanical openings and a firm, pliable body. As it aged, the flavour became intensified and the body became smooth and waxy.

TABLE 1

Evaluation of experimental Cheddar cheese made by the U.S.D.A. labour-saving method

	Utah		*Washington*		*Total*	
Evaluation	*Number of persons*	*%*	*Number of persons*	*%*	*Number of persons*	*%*
Excellent	2	7	14	25	16	19
Very good	—	—	7	12·5	7	8
Good	21	72	28	50	49	58
Fair	6	21	7	12·5	13	15
Poor	—	—	—	—	—	—
Total	29		56		85	

Samples of cheese made in the Department's pilot-plant and ripened for 8 months were examined and evaluated by commercial cheese-makers, dairy manufacturers and university dairy staff members attending the 24th Annual Utah Dairy Manufacturing Short Course, Utah State University, Logan, Utah, 4–7 March 1958, and the 27th

Annual Institute of Dairying, State College of Washington, Pullman, Washington, 10–13 March 1958. The evaluations, expressed by secret ballot, are tabulated in Table 1.

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SUMMARY

Some of the important, recent changes in methods and equipment used in the manufacture of Cheddar cheese are reviewed. Attention is directed particularly to numerous attempts to reduce the labour and time required with the aim of reducing manufacturing costs. Mechanized procedures are emphasized.

A new labour-saving method for making Cheddar cheese of good quality without the conventional, tedious and labour-requiring matting or cheddaring procedure has been developed by the United States Department of Agriculture. With the new method, the conventional U.S.D.A. 7-h method is followed, except during the period from draining the whey to milling the curd. At the usual time for draining off the whey, the mixture of curd and whey is pumped into a perforated curd-retaining vessel; the whey is drained off; and the curd is allowed to form one large block. Later the curd is milled and handled in the conventional manner. Thus, the hand labour involved in repeatedly handling and turning many small blocks of curd in the conventional method is eliminated.

Cheese made with this method has had the same general characteristics and composition as cheese made with the conventional method. It has had a typical Cheddar-cheese flavour, a few mechanical openings and a firm, pliable body.

LA MECANISATION DE LA PREPARATION DU FROMAGE DE CHEDDAR

RESUME

On passe en revue certaines innovations importantes apportées récemment aux procédés et aux moyens employés dans la production du fromage de Cheddar. On

souligne surtout les nombreuses tentatives visant à réduire le coût de production par une réduction du temps et du travail nécessaires. On insiste sur les procédés rendus mécaniques.

Le United States Department of Agriculture a mis sur pied une nouvelle méthode qui permet de fabriquer du fromage de Cheddar de bonne qualité tout en réduisant le travail grâce à l'élimination du procédé conventionnel de liaison ou «chedderisation», qui était fatigant et demandait beaucoup de travail.

Le nouveau procédé suit le procédé conventionnel de 7 h employé par le U.S.D.A., à l'exception du stade qui va de l'écoulement du petit lait au barattage du lait caillé. Au moment où le petit lait doit être normalement égoutté, le mélange de petit lait et de lait caillé est pompé dans un moule qui retient le caillé; le petit lait s'égoutte; et le caillé se dépose sous la forme d'un seul grand bloc. Ensuite on baratte et traite le caillé de la manière conventionnelle. Ainsi, on élimine le travail manuel inclus dans le maniement et le barattage conventionnel de nombreux petits blocs de caillé.

Le fromage fabriqué par ce procédé présente les mêmes caractères généraux et la même composition que le fromage fabriqué par le procédé conventionnel. Il a la saveur typique du fromage de Cheddar, quelques ouvertures mécaniques, et une consistance ferme et élastique.

MECHANISIERUNG DER CHEDDERKÄSEHERSTELLUNG

ZUSAMMENFASSUNG

Besprochen werden einige der wichtigen, neusten Wechsel der Methoden und Einrichtungen in der Herstellung von Cheddarkäse. Besondere Aufmerksamkeit ist auf die zahlreichen Versuche gerichtet, benötigte Arbeitskräfte und Zeit zu reduzieren mit dem Ziel, dadurch die Herstellungskosten herabzusetzen. Mechanisierte Vorgänge werden betont.

Eine neue, Arbeitskräfte sparende Methode in der Herstellung von Cheddarkäse von guter Qualität, ist von dem United States Department of Agriculture entwickelt worden, die das konventionelle, langwierige Verfahren der Verflechtung oder „cheddaring" mit vielen Arbeitskräften erübrigt.

Mit der neuen Methode verwendet man die konventionelle U.S.D.A. 7 Stunden Methode, mit Ausnahme der Zeitspanne der Entwässerung der Molke und Rühren des Quarkkäses. Zur gewöhnlichen Zeit wird die Mischung von Molke und Quarkkäse in eine Quarkkäseform gepumpt; man lässt den Quarkkäse einen langen Block formen. Später wird der Quarkkäse umgerührt und in der üblicher Weise verarbeitet. Auf diese Art wird die Handarbeit beseitigt, die in der wiederholten Handhabung und Drehung von vielen kleinen Blocks von Quarkkäse in der konventionellen Methode stattfindet.

Käse, der auf diese Art hergestellt wird, hat dieselben allgemeinen Merkmale und Zusammensetzung, wie Käse der in der konventionellen Methode hergestellt wird. Er hat einen typischen Cheddarkäse Geschmack, einige mechanische Löcher, und eine feste, biegsame Masse.

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